BEST PRACTICES

Establishing a Lubricant Analysis Program

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At Bently Nevada Corporation (BNC) we know one of the most effective ways to market our products is to practice what we preach. During the construction of our new corporate headquarters (Figure 1), the critical and balance-of-plant machinery was equipped with our state-of-the-art Machinery Management Systems. From our customers we have learned the importance of purchasing machinery and equipment that is properly designed, installed, balanced, aligned, lubricated, and managed. We know that if everything is done right from a maintenance perspective, machine life is greatly determined by how it is operated. For this reason Bently correlates machine operation with data from vibration and position sensors permanently installed on the machinery. This information, coupled with the information obtained from our Lubricant Analysis Program, complements a complete Asset Care Program. Having established a Lubricant Analysis Program for our new corporate headquarters, we thought it would be beneficial to describe how to put such a program into practice. Then you could do it yourself or BNC could assist you with one.

Figure 1 – Bently Nevada Corporation headquarters, Minden, Nevada.

An effective Lubricant Analysis Program must have the following elements:

- Defined Objectives
- Effective Program Design
- Program Implementation Plan
- Program Management Strategy

These elements will be described in detail using our corporate headquarters as an example. This same process could easily be implemented at your plant or facility.

Defining Objectives

"It is best to know where you are going, how else will you know when you have arrived?" Prior to defining our

Machinery in BNC's Fluid Sampling Program

MANUFACTURER	DESCRIPTION	NO. OF UNITS	NO. OF SAMPLE POINTS	FLUID SAMPLED	SAMPLING INTERVAL
Busch	Vacuum Pump	2	2	Oil	1 month
Joy	Screw Compressor	3	3	Oil	1 month
Trane	Rotary Chiller	2	2	Oil	3 months
Caterpillar	Standby Generator	2	2	Oil	3 months
			2	Coolant	6 months
Marathon Equipment	Vertical Baler	1	1	Oil	6 months
	Trash Compactor	1	1	Oil	6 months
Otis	Elevator	2	2	Oil	6 months
Total Number of Sample Points			**15**		

Table 1.

own objectives for this project, we researched lubricant analysis technology and best practices, attended training seminars, and developed both internal and customer programs. You could follow a similar plan or select an outside supplier such as BNC to help determine your objectives.

Lubricant Analysis Program objectives can range from simple condition-based monitoring to an overall proactive Asset Care Plan. Condition-based monitoring allows you to optimize planned repairs and lubricant changes. The Asset Care Plan reduces repair costs and increases machinery availability.

BNC chose the Asset Care Plan to optimize machinery availability and decrease overall maintenance expenditures.

Program Design

Situation Assessment

It is best at this point to determine how to reach the chosen objective. In our case, all equipment was new and recently installed and thus a simplified process. With no immediate improvements to implement, the equipment survey was the first step in the process.

Machine Selection and Sample Frequency

The purpose of the equipment survey is to identify and list all of the machines to be incorporated into the lubricant analysis program. It should include: manufacturer, machine description, number of units, number of sample points, manufacturer's recommendations for lubricant or type of fluid, and fluid sampling frequency. This equipment survey differs from a lubrication survey that simply identifies all the plant equipment and reviews each application for optimum lubricant application. Lacking a manufacturer's recommendation for sample frequency, industry best practice should be employed. This is typically once per month for industrial machinery operating 100% of the time and less frequently for machinery with lower utilization. Table 1 lists the machines and sample frequencies for Bently Nevada's new corporate headquarters.

Laboratory Tests

Bently Nevada selected the following test regimes:

- Emission Spectroscopy for 20 metals
- Neutralization Number
  - › Total Acid Number for industrial-type equipment
  - › Total Base Number for internal combustion engines
- Kinematic Viscosity
  - › @ 40 °C (104 °F) for industrial-type equipment
  - › @ 100 °C (212 °F) for internal combustion engines
- % Solids

- Karl Fischer Titration for water
- Direct Read Ferrography
- Standard coolant analysis for coolants

Program Implementation

Training

Program participants should be trained in the following: importance of lubrication, how to collect oil samples safely and correctly, proper lubricant testing procedures, and any site-specific requirements, i.e., unique sampling methods. Bently Nevada continually conducts training for our personnel.

Sample Points

Fluid analysis sample points are determined by recommendations from the manufacturer or from locations where the best representative sample can be collected. In each case a primary sample location should be chosen as a control sample location. A control sample point is best located downstream of the system being lubricated and prior to the sump. If abnormal changes in the primary sample are observed, then the secondary sample points are used to isolate the source of contaminants, which could include the filter and the sump. For most of the machines listed, only primary sample locations have been specified. More complex machines (i.e., machines with more bearings lubricated by the same system) may require multiple secondary sample locations to isolate potential problem sources.

Once the sample locations have been identified, it is important to evaluate how easily a sample can be taken at each point. If a sample cannot be taken easily from a particular machine, that machine should be retrofitted to facilitate the process. For example, BNC has two Caterpillar Emergency Diesel Generators for backup power. The location of choice for live sampling on these generators is one of two plugs on the front face of the oil filter block, shown in Figure 2.

One of these two plugs is designed to be the fluid sampling valve and the other is a pressure port. The oil at these plugs has been through the sump, oil pump, the block and heads, and then into the oil cooler. If there are failures in any of these systems, then oil analysis from this location should be able to detect them. How does it distinguish the problem source?

The plug of interest is a 1/4" NPT plug, but the CAT sample valve has 7/16-20 UNF threads, and is therefore incompatible. Consequently, some modification had to be done (Figure 3). The oil pressure at these plugs is approximately 50 psi (345 kPa) for normal operation, with the bypass set at 75 psi (517 kPa). Both of these pressures are well below the maximum operating pressure of the sampling valve (508 psi, or 3503 kPa) and the maximum operating pressure of the reducer fitting (150 psi, or 1034 kPa). Therefore maximum operating pressure of the valve was not significantly changed by the modification.

Sample Procedures

Safety is of the utmost concern in sample collection and is emphasized in training and all aspects of the procedures. Procedures that outline the steps to safely collect a sample should be defined and documented for each type of equipment in the facility.

Each unique sample point should have its own defined procedure. For example, the following is BNC's procedure for the diesel generators and the air compressors:

Figure 2 – Typical Oil Filter Block before modification.

Figure 3 – Typical Oil Filter Block after modification.

Applicable Machinery:

- Emergency Diesel Generators (Engine Oil and Coolant)
- Air Compressors

Equipment Required:

- New sample bottle
- Clean, sampling probe for each sample
- Approximately 1 foot of sample tubing for each sample (tube length will vary for different types of equipment – this is only representative of our equipment)
- Label for each sample
- Waste container
- Tubing Cutter
- Rag
- Safety glasses
- Gloves
- Material Safety Data Sheets

Caution: The machinery is hot and the fluid is pressurized. Ensure that Operations is aware that a sample is being collected and precautions are maintained to avoid inadvertent machinery shutdown. Proper safety equipment must be worn at all times (safety glasses and gloves).

Procedure:

1. The air compressor fluid sampling valves are located near the oil filter (Figure 4). The generator coolant sampling valve is located on the block side of the lower radiator hose on the oil filter side. Each valve is covered with a black cap for dust protection.

Caution: The generators make a lot of noise and wind. Wear hearing protection and restrain loose clothing.

Figure 4 – Sample plug modification.

2. Take samples only if the unit has been in operation for at least half an hour. If not in operation, get someone to start it. (For the generators, schedule sampling for when they are scheduled to run.)
3. Look around the fluid system, including the valve, for fluid leakage. If any leakage is observed, report it to Facilities personnel immediately. (During normal operation, a live fluid-sampling valve may have a slight film on its end.)
4. Check fluid level prior to sample. Do not sample unless sufficient fluid reserve is present.
5. Remove the black cap covering the valve.
6. Slide tubing onto probe and place one end into the waste container (Figure 5).

Figure 5 – Sample tubing.

7. Place one end of the tubing in the waste container and snap the probe into the valve. Push the probe in to get fluid flow.
8. Withdraw approximately 100 ml (4 fl oz) of fluid into the waste container (3/4 of a sample bottle). This process cleans the valve and helps ensure a representative sample.
9. Place the waste container in a safe place.
10. Fill the sample bottle to three-quarters full.
11. Remove the probe and tubing.
12. Check fluid level. If system needs to be filled, inform Facilities personnel.
13. Replace valve cap.
14. Fill out the label and place it on the sample bottle.
15. Clean up after yourself.
16. Return all equipment, waste, and waste fluid to the Bently Nevada Oil Lab.

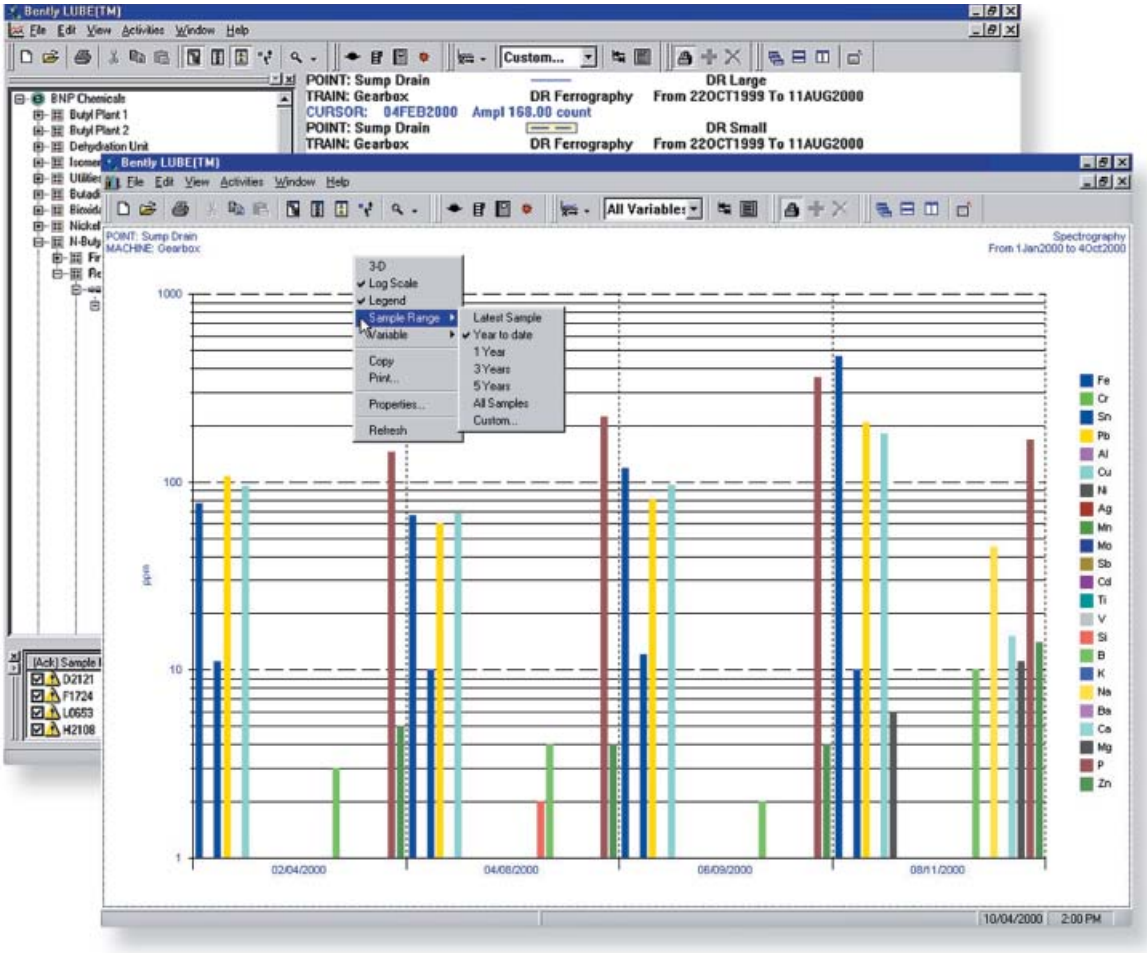

Figure 6 – Screens from Bently LUBE™ software.

17. Properly dispose of all waste in the properly marked receptacles.

Program Management

Three things that program management should deliver are:

1. A Program Manual
2. Actionable Information℠
3. Documentation

Program Manual

The program manual should contain the sampling procedures, the tests being conducted for each type of equipment, and up-to-date equipment survey that tracks machinery and lubricant updates.

Actionable Information

The collected data is electronically transmitted from the lab and incorporated into Bently LUBE™, our newly released Lube Oil Analysis Software Program (Figure 6 shows typical screens from the Bently LUBE™ software program).

Using this program, it is easy to flag exceptions and evaluate trends and generate reports from collected sample data. Figure 7 is an example of a standard report with its associated Actionable Information℠.

Documentation

It is important to keep track of machine saves, maintenance costs averted, and lessons learned. A critical part of this effort is communication between operations, maintenance, and reliability groups. This will help in future equipment planning and management techniques, such as continual optimization of our proactive Asset Care Program for BNC's corporate headquarters' machinery.

Summary

A strategic lubrication program should be a part of an overall proactive Asset Care Program. "Best of Class" companies will achieve high equipment availability using

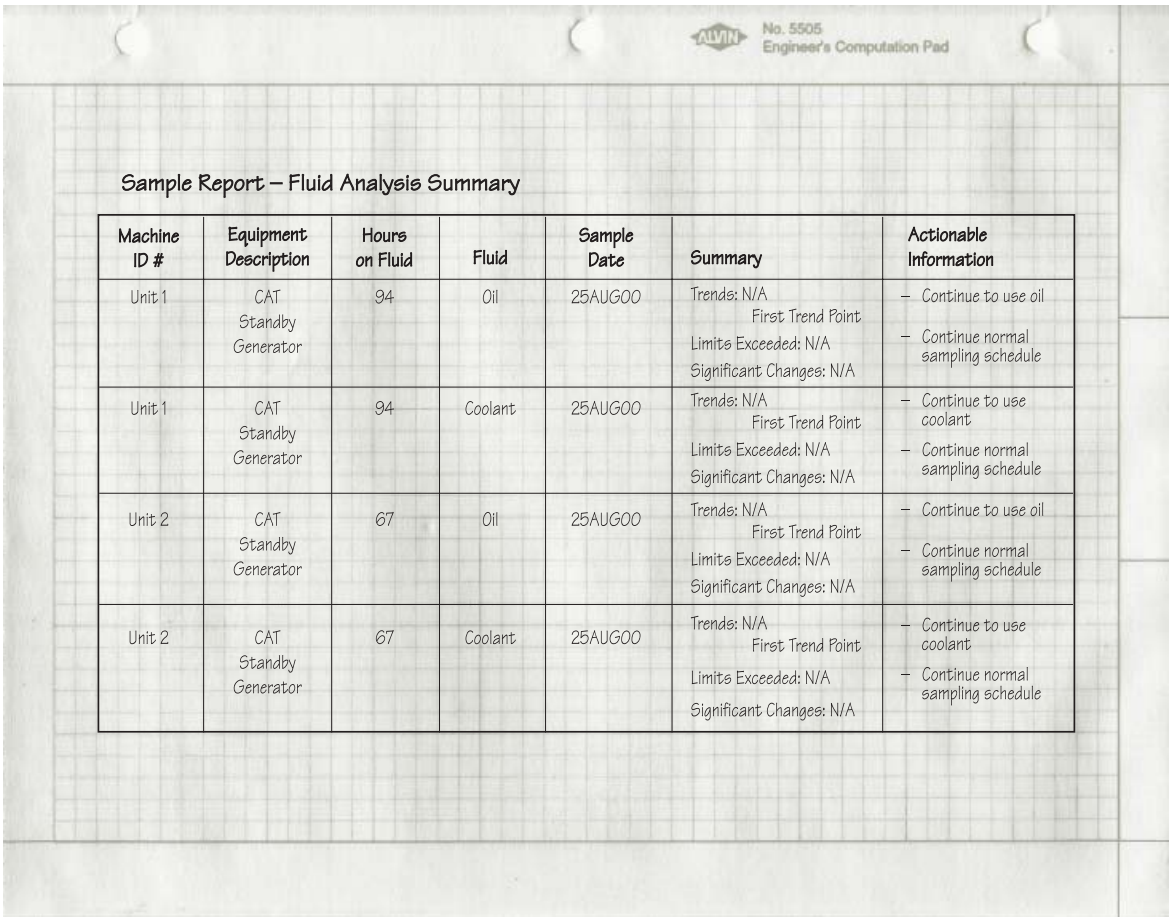

Figure 7 – Example Fluid Analysis Report.

proactive maintenance and reliability programs. Bently Nevada has the expertise to:

- Establish effective lubricant analysis programs.
- Review and evaluate lubricant selections for specific applications.
- Determine which lubricants can be used in a larger equipment population to take advantage of bulk purchases and reduced storage needs without compromising individual equipment requirements.
- Resolve lubrication-related failures utilizing fundamental root cause failure analysis techniques to eliminate future breakdowns.
- Perform site or operating unit lubrication surveys to optimize lubrication programs/systems.

An effective lubricant analysis program will promote equipment availability, reduce or eliminate lubrication problems, protect operating equipment against excessive or premature wear, reduce plant delays and downtime, and reduce maintenance overall operating cost. If you need assistance in establishing a Lubricant Analysis Program, please call us.